FIG. 1

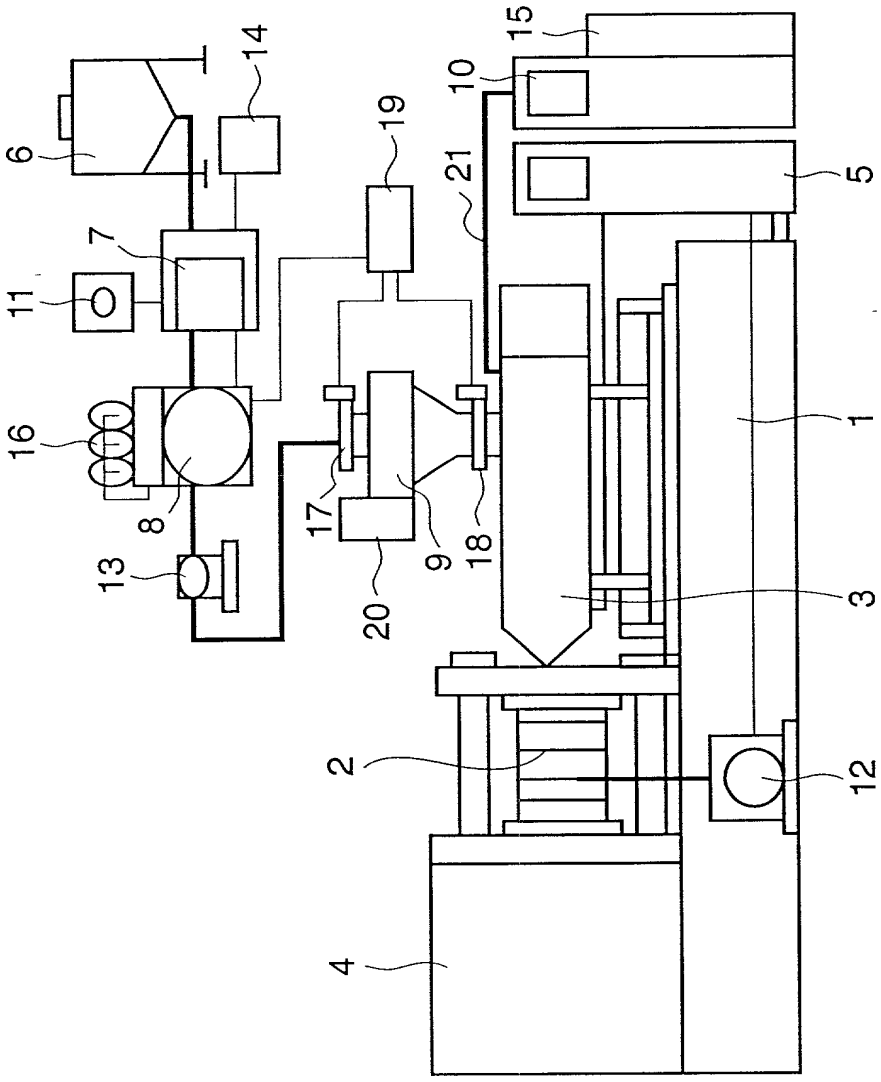

FIG. 2

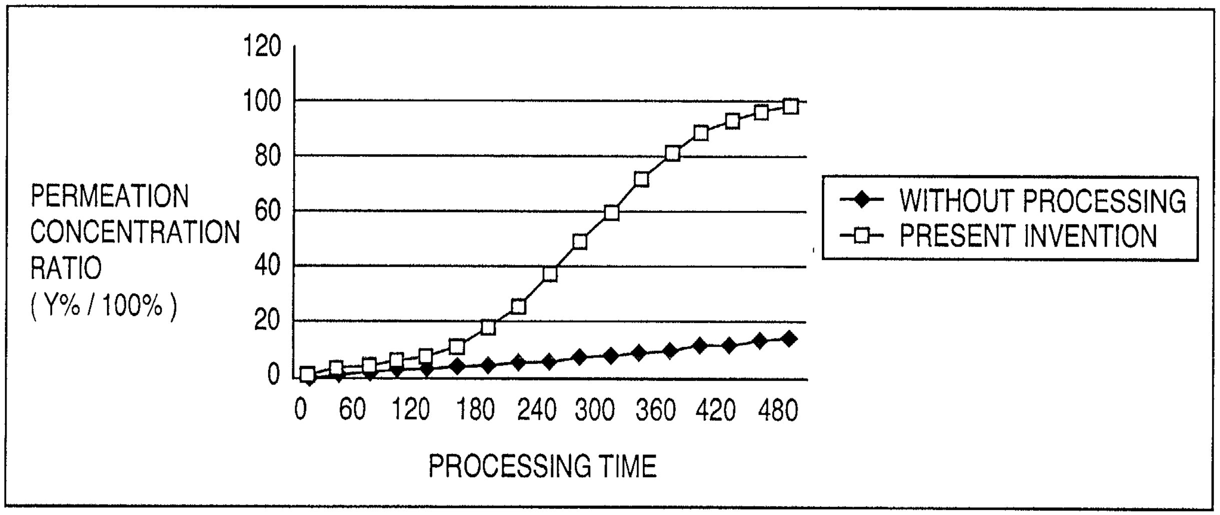
PERMEATION CONCENTRATION RATIO (Y% / 100%)
120
100
80
60
40
20
0
0 60 120 180 240 300 360 420 480
PROCESSING TIME
WITHOUT PROCESSING
PRESENT INVENTION

FIG. 3

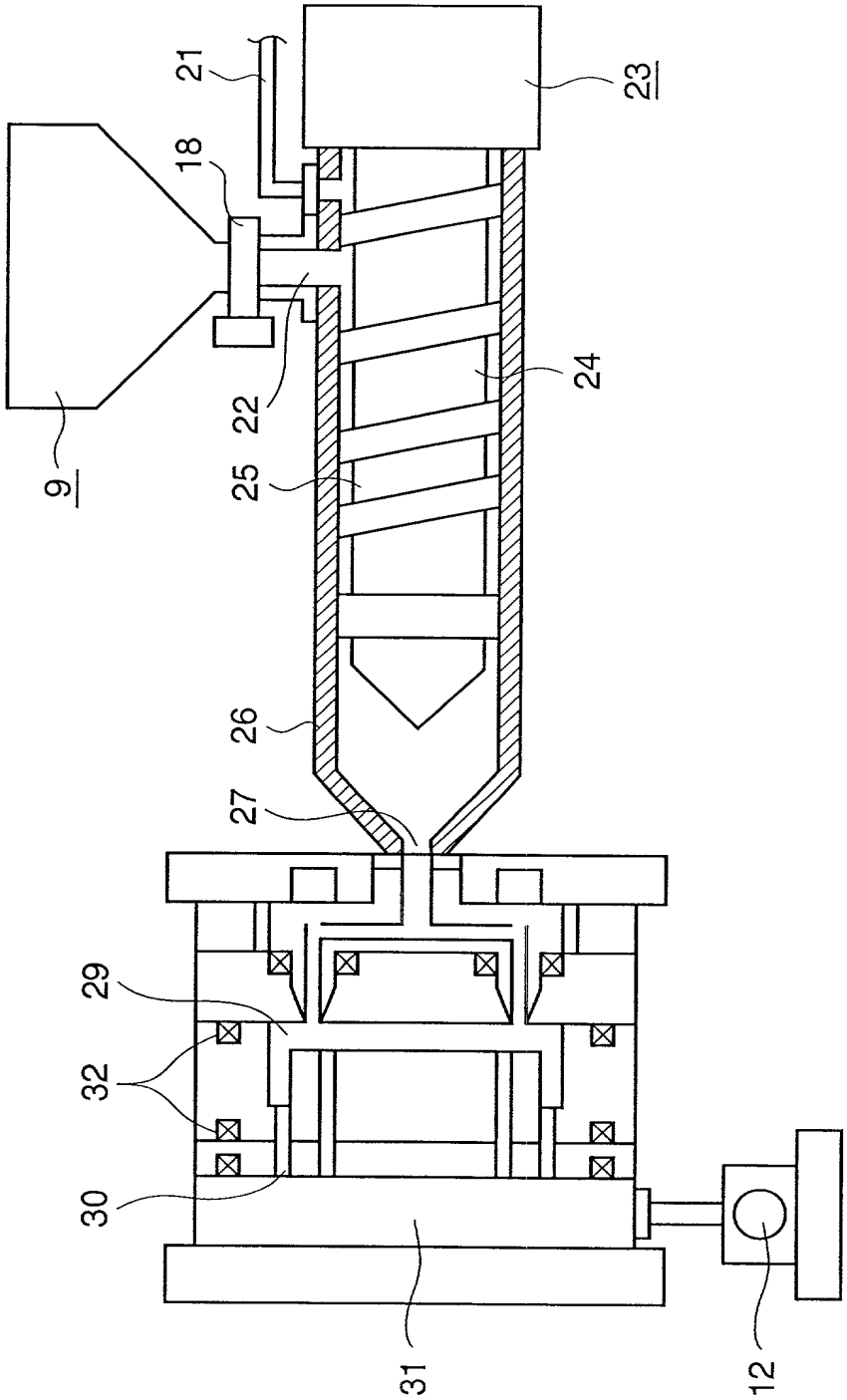

FIG. 4

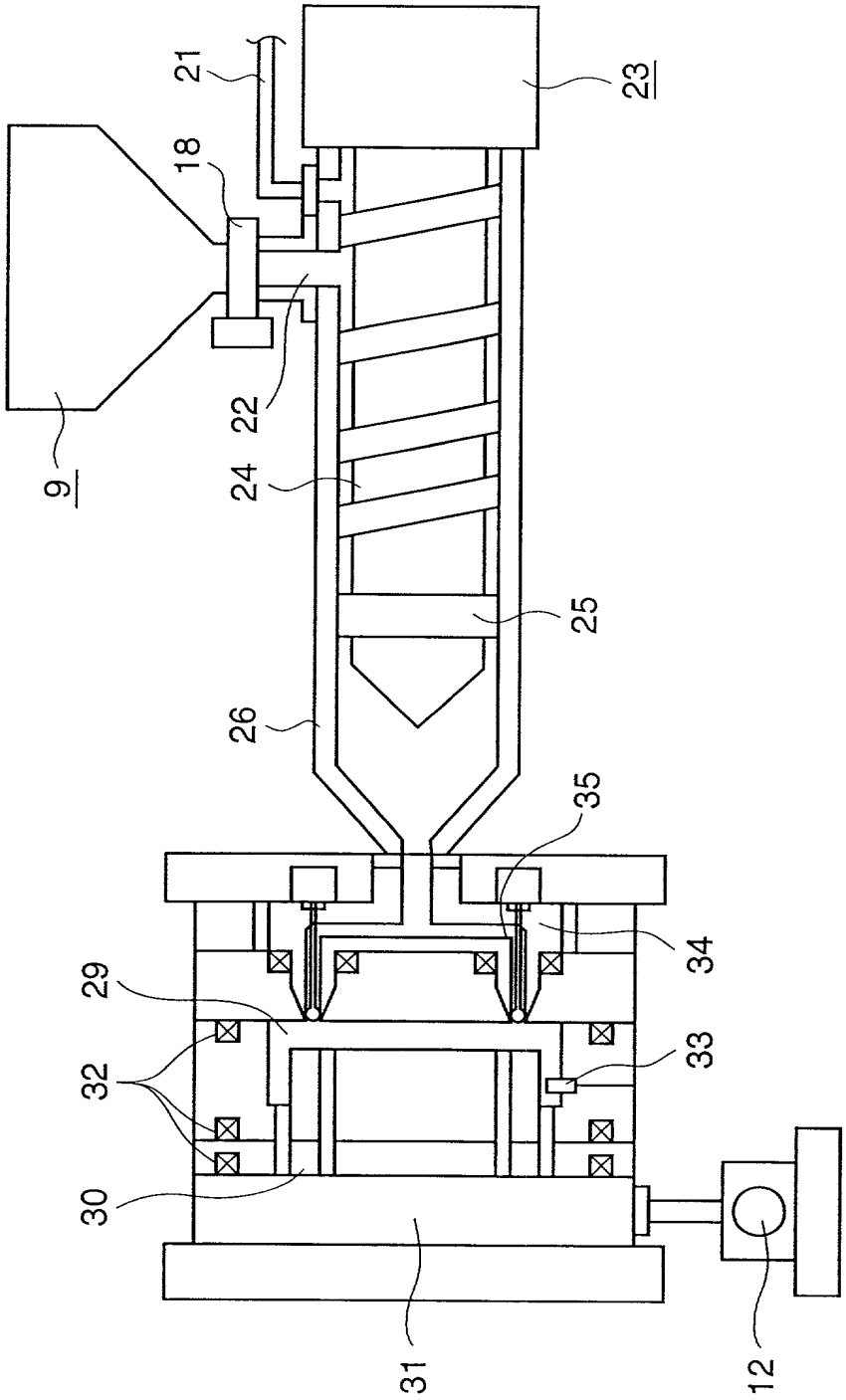

FIG. 5

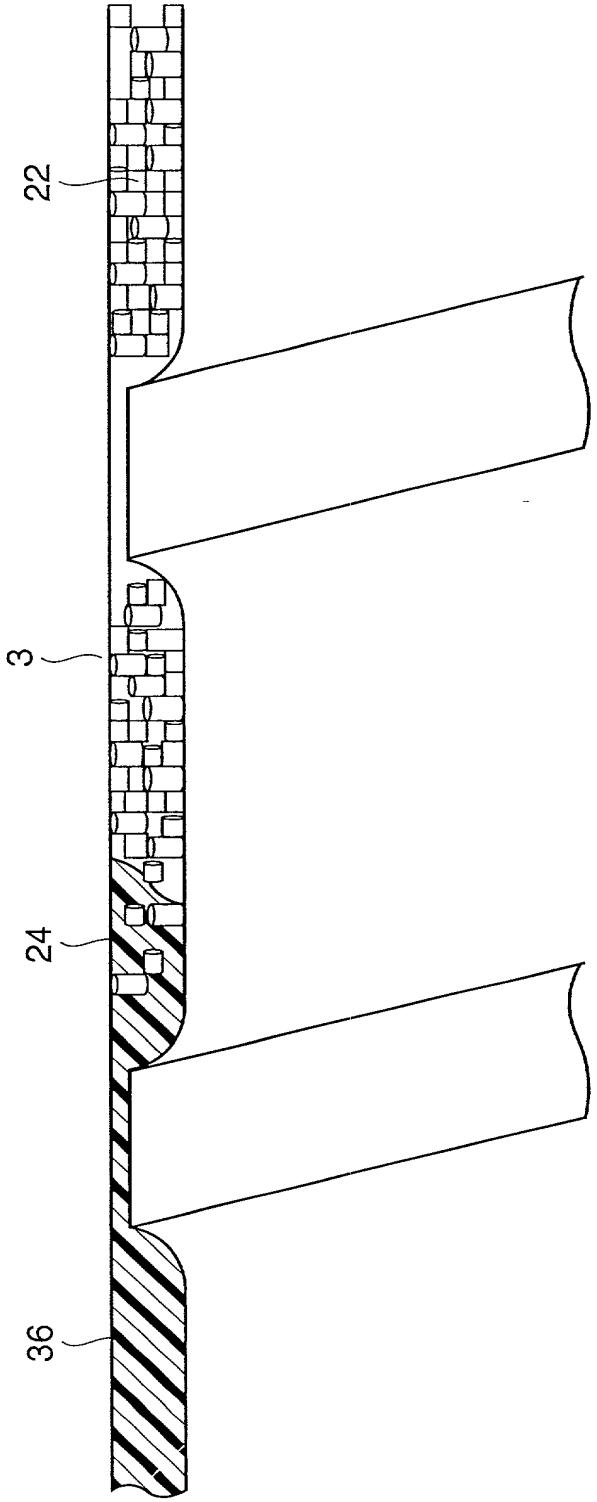

FIG. 6

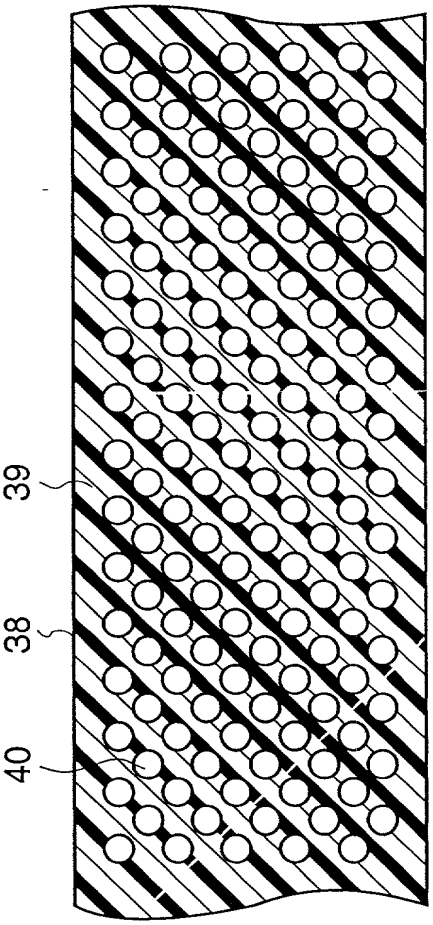

FIG. 7

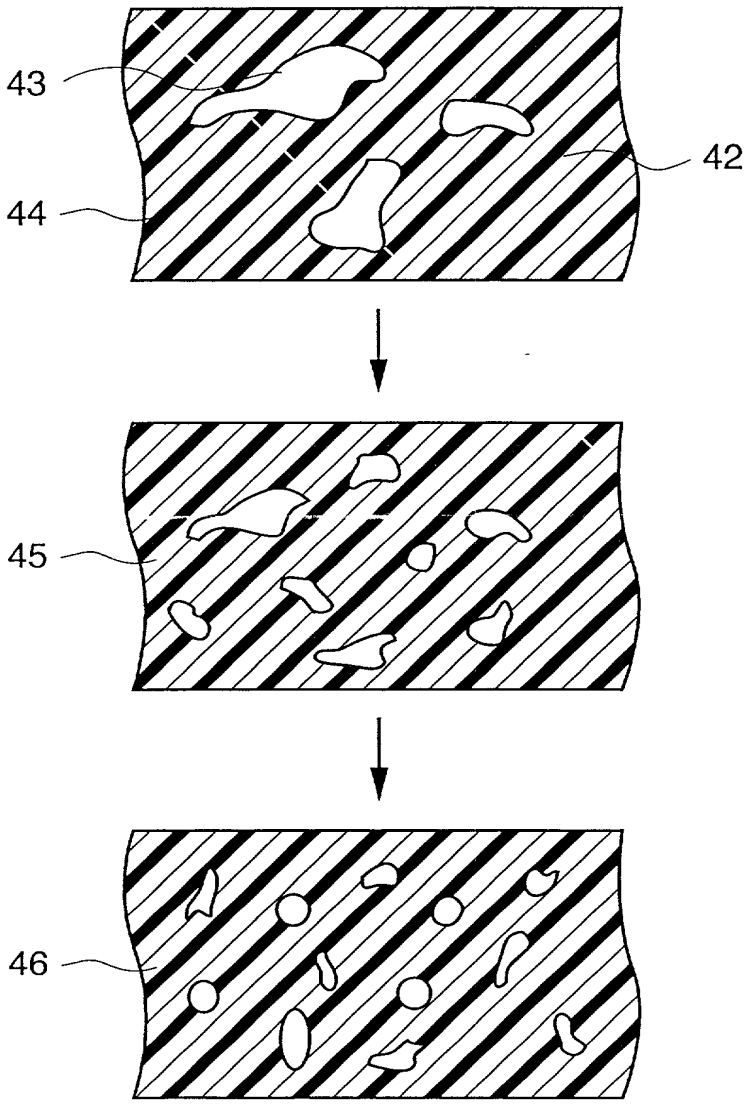

FIG. 8

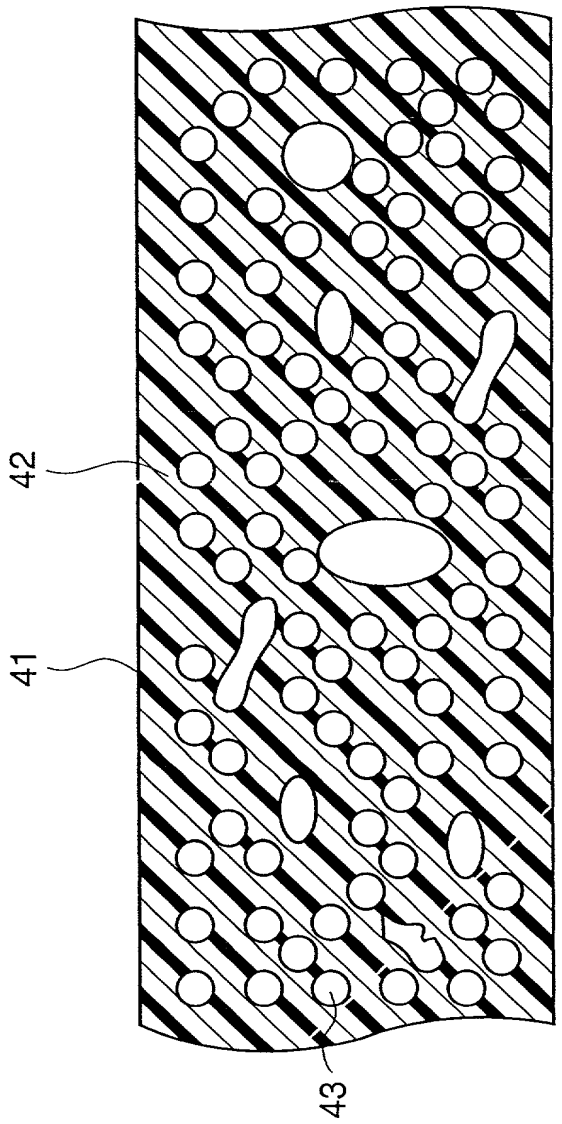

FIG. 9

	INJECTION TIME sec	HOLDING PRESSURE TIME sec	COOLING TIME sec METERING TIME sec	MOLD OPENING / CLOSING EXTRACTION TIME sec	MOLDING CYCLE sec
GENERAL MOLDING	2	4	10	10	26
* WITHOUT FORMING			6		
CONVENTIONAL FOAM MOLDING	2.5	0	7	10	
			20		32.5
FORM MOLDING ACCORDING TO PRESENT INVENTION	0.8	0	6	10	16.8
			5		

FIG. 10

FILLING TIME sec	INJECTION PROCESS	DURING INJECTION / CHARGE			
	AMBIENT PRESSURE IN CAVITY BEFORE FILLING	NEAR GATE		NEAR FINALLY FILLED PORTION	
		INTERNAL PRESSURE Mpa	CELL DIAMETER μm	INTERNAL PRESSURE Mpa	CELL DIAMETER μm
0.5	VACUUM 0.0001 Mpa	60	9	54	13
1	VACUUM 0.0001 Mpa	62	10	49	15
2	ATMOSPHERIC PRESSURE	63	22	14	75
3	GAS FILLING 2 Mpa	62	23	9	120

		CONDITION 1	CONDITION 2	CONDITION 3	CONDITION 4	CONDITION 5
	RESIN MATERIAL	PC/ABS	PC	PPE+PS	ABS	HIPS
DEHUMIDIFIER / DRYER UNIT	TIME (MIN)	120	240	120	120	120
	REPLACEMENT GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS
	TEMPERATURE (℃)	90	120	90	80	70
GAS PERMEATION UNIT	TIME (MIN)	480	480	480	480	360
	REPLACEMENT GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS
	TEMPERATURE (℃)	90	110	90	80	70
	PRESSURE (Mpa)	6	6	6	6	5
MATERIAL HOPPER	TIME (MIN)	180	180	180	180	120
	REPLACEMENT GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS
	TEMPERATURE (℃)	90	110	90	80	70
	PRESSURE (Mpa)	6	6	6	6	6
METERING PORTION	REPLACEMENT GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS	CO_2 GAS
	TEMPERATURE (℃)	60	60	60	50	40
	PRESSURE (Mpa)	4	4	4	4	4
PLASTICIZING UNIT	BACK PRESSURE (Mpa)	10	10	10	8	8
	NOZZLE TEMPERATURE (℃)	220	260	260	200	160
	PLASTICIZING UNIT TEMPERATURE (℃)	210	250	250	190	150
	TEMPERATURE BELOW HOPPER (℃)	60	60	60	50	40
	INJECTION PRESSURE (Mpa)	120	140	150	110	120
	INJECTION SPEED (m/sec)	2	2	2	3	4
	INJECTION TIME (sec)	0.8	0.8	0.8	0.6	0.4
	HOLDING PRESSURE (Mpa)	60	70	70	55	45
	HOLDING PRESSURE TIME (sec)	2.5	2	2	2.5	3
	COOLING TIME (sec)	8	7	6	8	10
	MOLDING CYCLE (sec)	25	23.5	22.5	24.8	27.1
DEGREE OF VACUUM	PRESSURE (Pa)	200	150	200	100	100
MOLDED PRODUCT	PART WEIGHT (g)	246	255	268	221	215
	AVERAGE CELL DIAMETER (μm)	16	9	19	16	8
	FOAMING RATIO (%)	18	20	17	21	24

* "TIME" IN "MATERIAL HOPPER" INDICATES THE TIME BETWEEN THE INSTANT AT WHICH A MATERIAL IS FED INTO THE HOPPER AND THE INSTANT AT WHICH THE MATERIAL IS FED INTO THE PLASTICIZING UNIT

* "FOAMING RATIO" IN "MOLDED PRODUCT" INDICATES THE RATIO OF WEIGHT REDUCTION OF FOAMED MOLDED PRODUCT TO THAT OF MOLDED PRODUCT WITHOUT FOAMING

CO_2 GAS · · ·
CARBON DIOXIDE GAS

FIG. 11A

		CONDITION 6	CONDITION 7	CONDITION 8	CONDITION 9	CONDITION 10	CONDITION 11
	RESIN MATERIAL	PC/ABS	PPE+PS	ABS	HIPS	PPS	PC
DEHUMIDIFIER / DRYER UNIT	TIME (MIN)	120	120	120	120	240	240
	REPLACEMENT GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS
	TEMPERATURE (℃)	70	70	60	50	80	70
GAS PERMEATION UNIT	TIME (MIN)	60	60	45	30	60	60
	REPLACEMENT GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS
	TEMPERATURE (℃)	50	50	45	40	60	50
	PRESSURE (Mpa)	4	5	3	1	5	3
MATERIAL HOPPER	TIME (MIN)	30	30	30	30	30	30
	REPLACEMENT GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS
	TEMPERATURE (℃)	70	70	60	50	80	70
	PRESSURE (Mpa)	0.5	0.7	0.4	0.1	0.7	0.4
METERING PORTION	REPLACEMENT GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS	N_2 GAS
	TEMPERATURE (℃)	45	45	45	45	45	45
	PRESSURE (Mpa)	0.5	0.7	0.4	0.1	0.7	0.4
PLASTICIZING UNIT	BACK PRESSURE (Mpa)	2	2.5	1.5	1	2.5	1.5
	NOZZLE TEMPERATURE (℃)	220	260	200	160	270	260
	PLASTICIZING UNIT TEMPERATURE (℃)	210	250	190	150	260	250
	TEMPERATURE BELOW HOPPER (℃)	45	45	45	45	45	45
	INJECTION PRESSURE (Mpa)	100	110	100	90	120	110
	INJECTION SPEED (m/sec)	2	2	2.5	2.5	2	2
	INJECTION TIME (sec)	0.8	0.9	0.7	0.6	0.8	0.9
	HOLDING PRESSURE (Mpa)	0	0	0	0	0	0
	HOLDING PRESSURE TIME (sec)	0	0	0	0	0	0
	COOLING TIME (sec)	8	7	8	8	9	7
	MOLDING CYCLE (sec)	21	20	21	21	22	20
DEGREE OF VACUUM	PRESSURE (Pa)	80	90	80	80	90	80
MOLDED PRODUCT	PART WEIGHT (g)	251	270	231	224	277	261
	AVERAGE CELL DIAMETER (μm)	26	100	33	48	15	10
	FOAMING RATIO (%)	13	19	19	5	12	20

* "TIME" IN "MATERIAL HOPPER" INDICATES THE TIME BETWEEN THE INSTANT AT WHICH A MATERIAL IS FED INTO THE HOPPER AND THE INSTANT AT WHICH THE MATERIAL IS FED INTO THE PLASTICIZING UNIT

* "FOAMING RATIO" IN "MOLDED PRODUCT" INDICATES THE RATIO OF WEIGHT REDUCTION OF FOAMED MOLDED PRODUCT TO THAT OF MOLDED PRODUCT WITHOUT FOAMING

N_2 GAS · · ·
NITROGEN GAS

FIG. 11B

FIG. 12

			MOLDED PRODUCT CELL SIZE			MECHANICAL CHARACTER-ISTICS	DIMENSIONAL PRECISION (WITH RESPECT TO REFERENCE SIZE OF 100 mm)	
	RESIN MATERIAL	GAS	AVERAGE DIAMETER	MAXIMUM DIAMETER	MINIMUM DIAMETER	BENDING MODULUS	CONTRACTION VARIATION	DIMENSIONAL VARIATION
MOLDED PRODUCT ACCORDING TO PRESENT INVENTION	PPE+PS	CO_2	19μm	25μm	10μm	4500Mpa	+−2%	+−0.05mm
CONVENTIONAL MOLDED PRODUCT	PPE+PS	CO_2	28μm	120μm	20μm	1800Mpa	+−15%	+−0.3mm
MOLDED PRODUCT ACCORDING TO PRESENT INVENTION	PC/ABS	N_2	26μm	35μm	10μm	22000Mpa	+−1.5%	+−0.04mm
CONVENTIONAL MOLDED PRODUCT	PC/ABS	N_2	35μm	90μm	18μm	19000Mpa	+−6.0%	+−0.11mm

FIG. 13

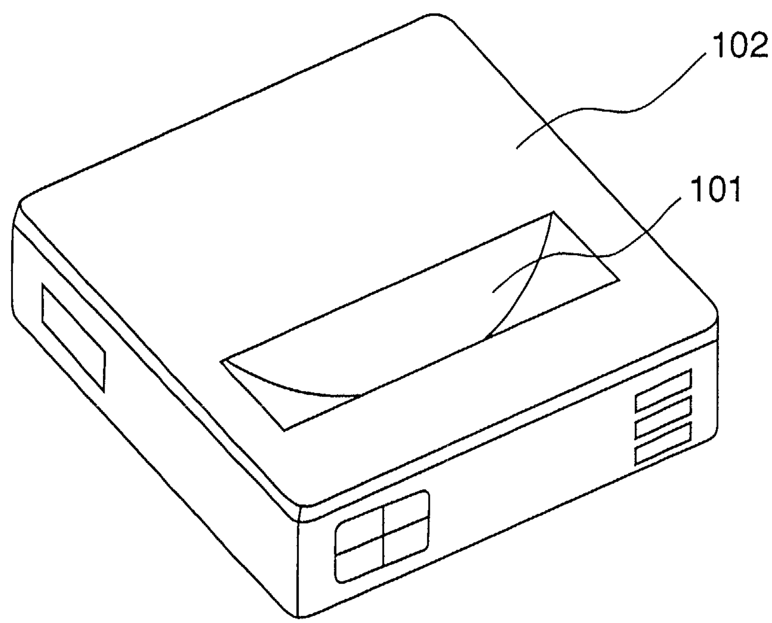

FIG. 14

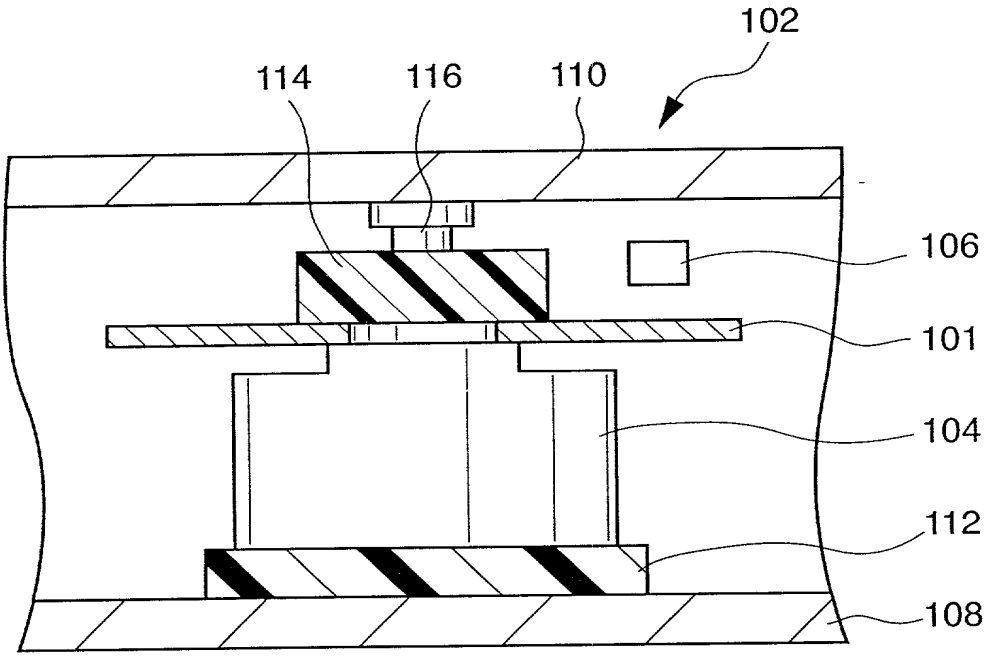

FIG. 15

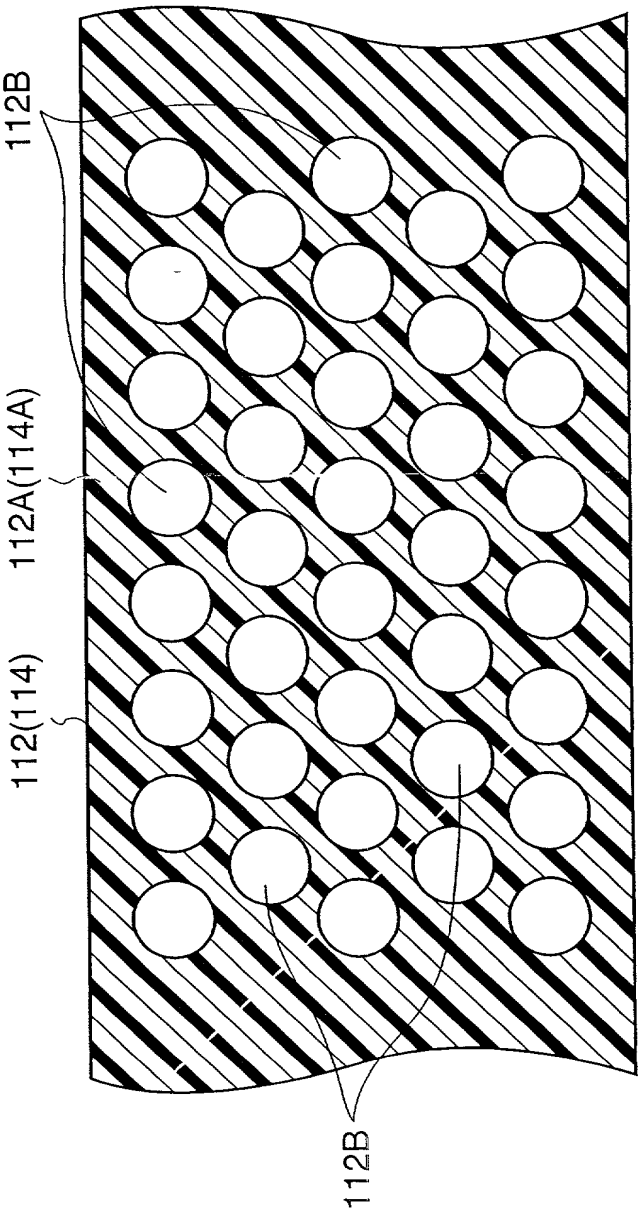

FIG. 16

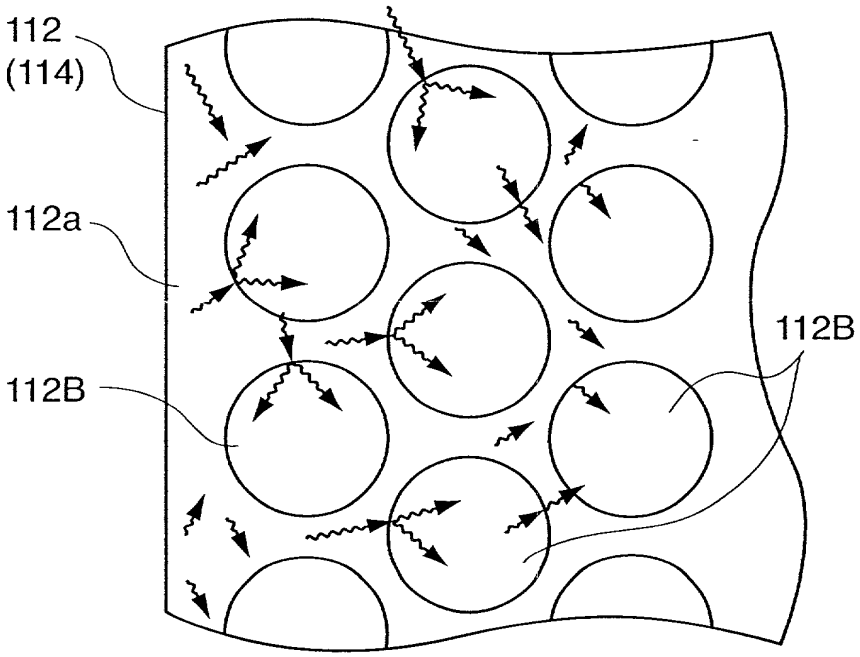

FIG. 17

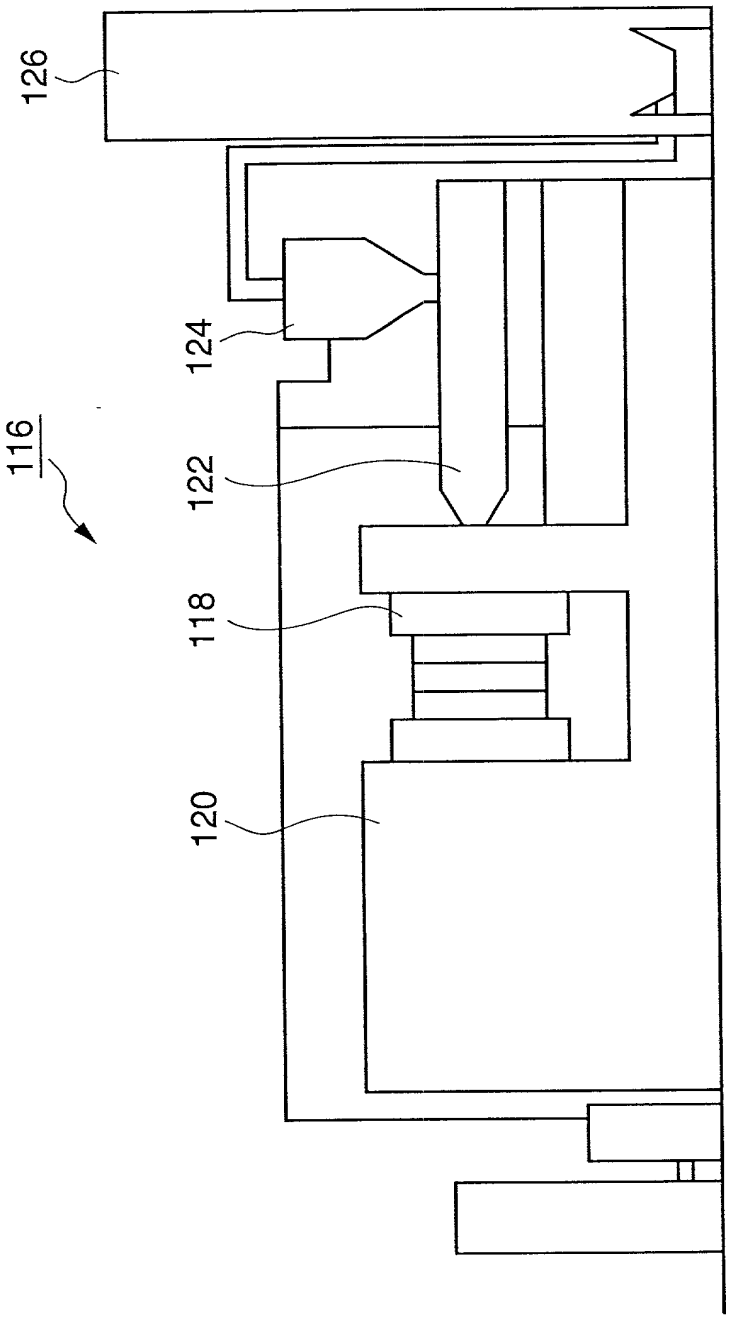

FIG. 18

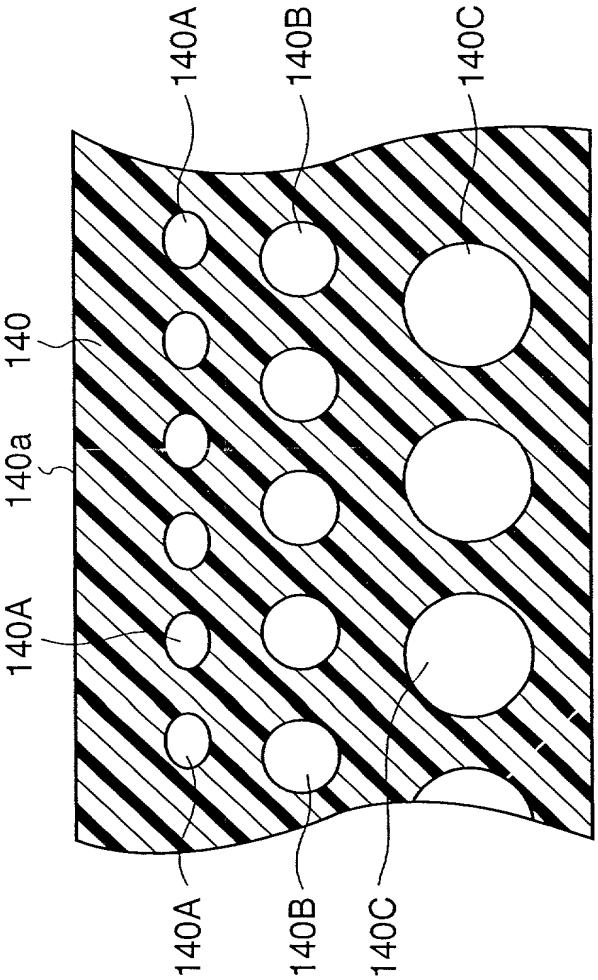

FIG. 19

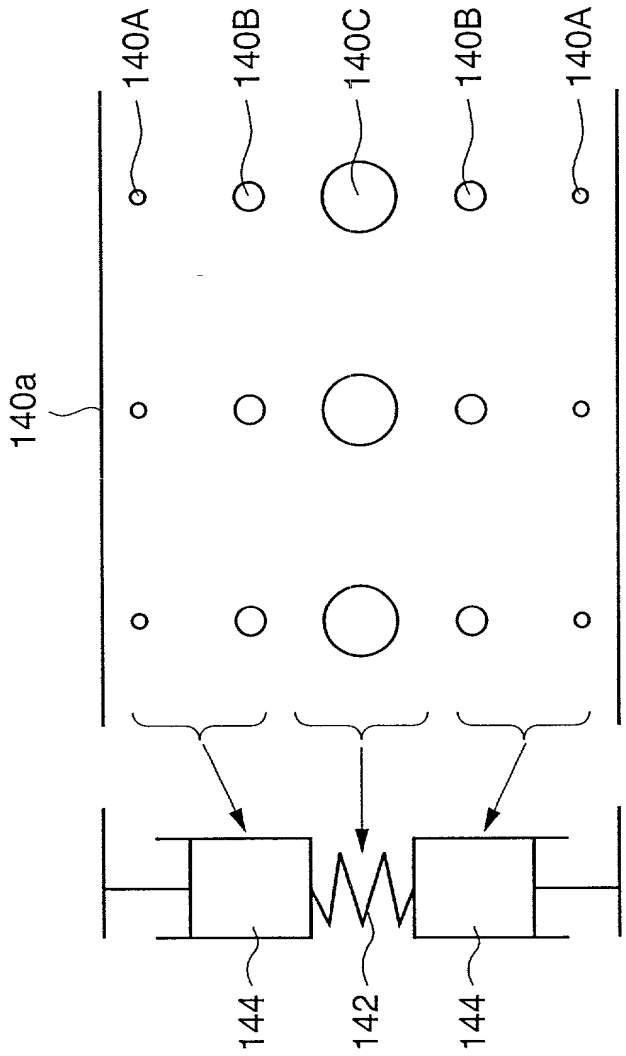

FIG. 20

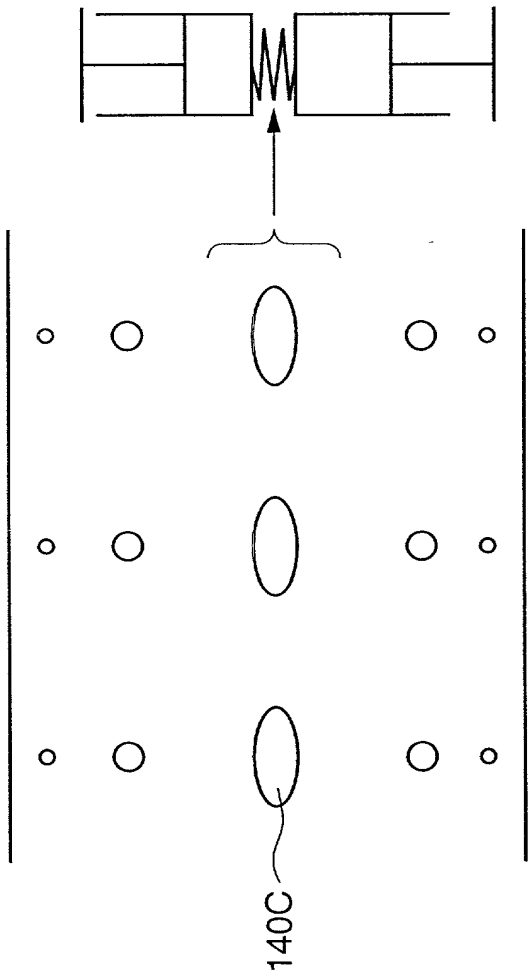

FIG. 21

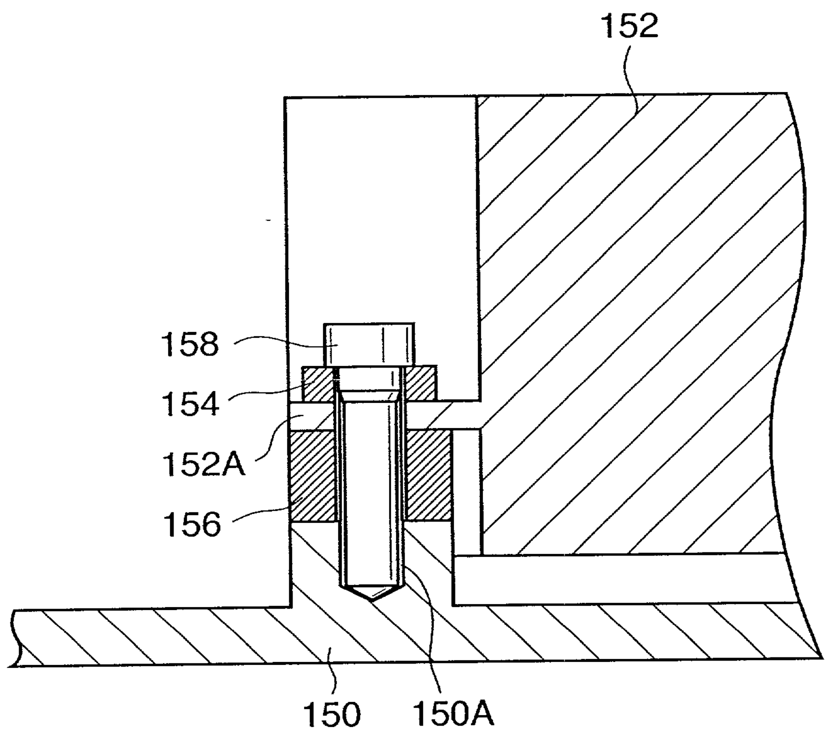

FIG. 22

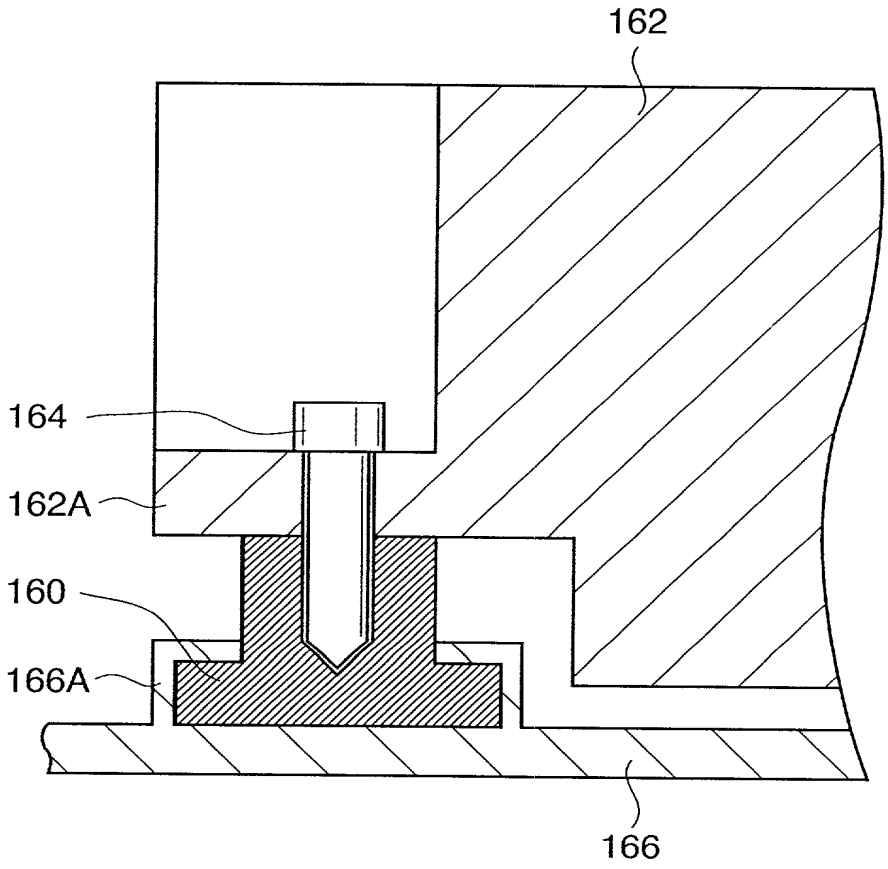

FIG. 23

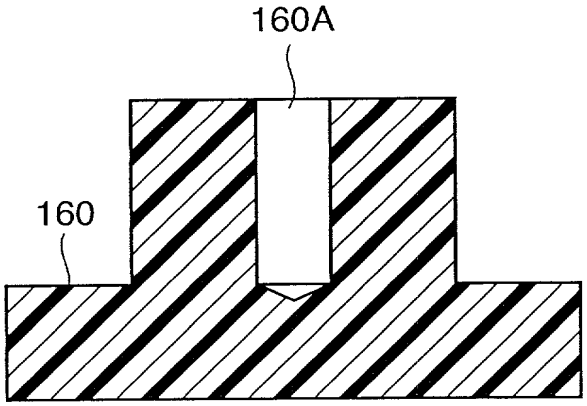

FIG. 24

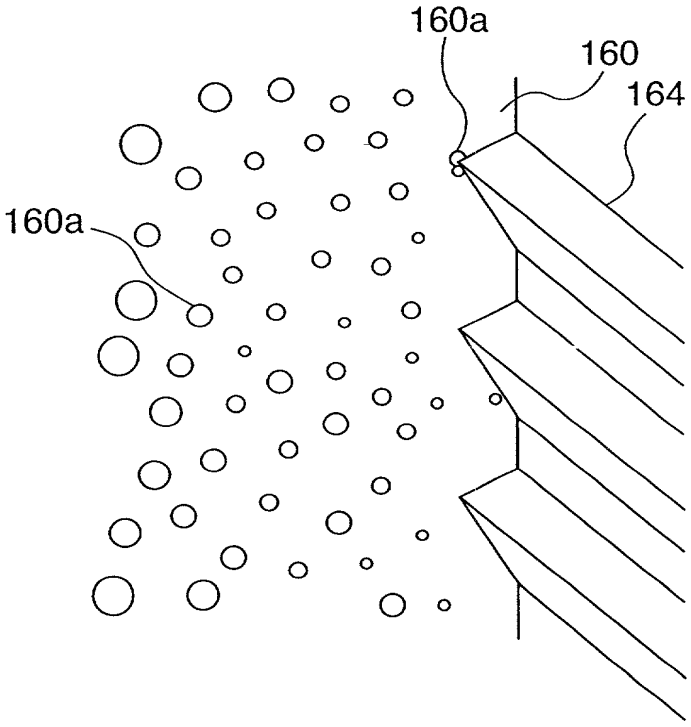

FIG. 25

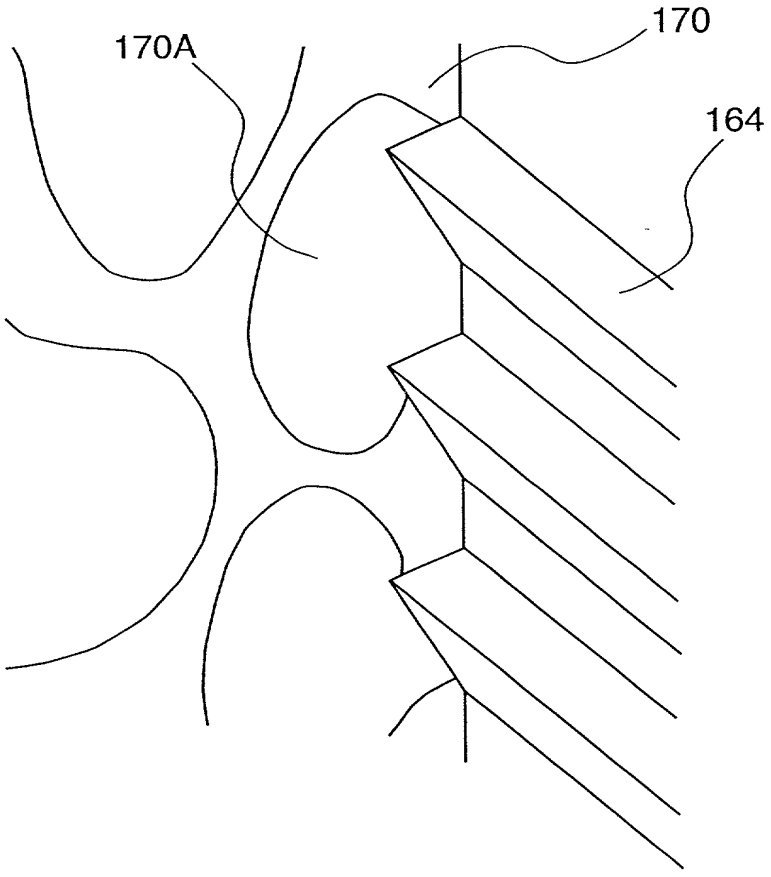

FIG. 26

RESIN MATERIAL	PPO	PPO	PC	POM	ABS	HIPS	PC/ABS	SI ELASTOMER	URETHANE ELASTOMER
CELL DIAMETER	10	60		20	50	75	15	60	100
THICKNESS mm	4	4	4	4	4	4	4	5	5
WEIGHT REDUCTION %	20	30	18	25	30	35	22	35	42

FIG. 27

MATERIAL TYPE	CELL DIAMETER μm	THICKNESS mm	DAMPING FACTOR dB/sec
PPO	60	4	62
PC		4	45
ABS	50	4	80
HIPS	75	4	90
PC/ABS	15	4	58
SI ELASTOMER	60	5	125
URETHANE ELASTOMER	100	5	134
CONVENTIONAL PRODUCT	***	***	24
ALUMINUM ALLOY	***	1	6

FIG. 28

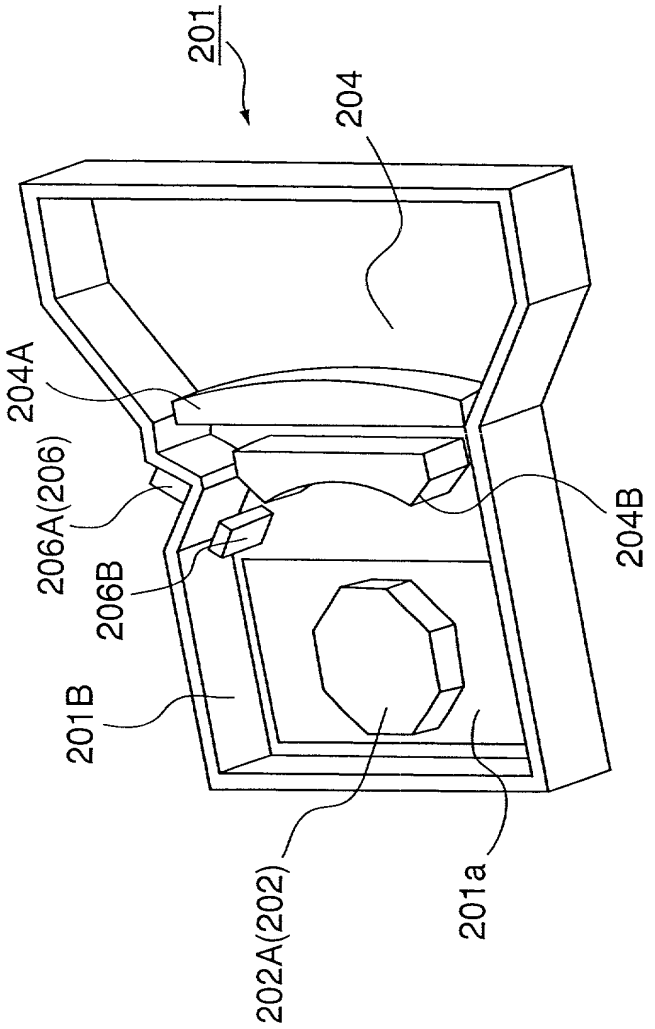

FIG. 29

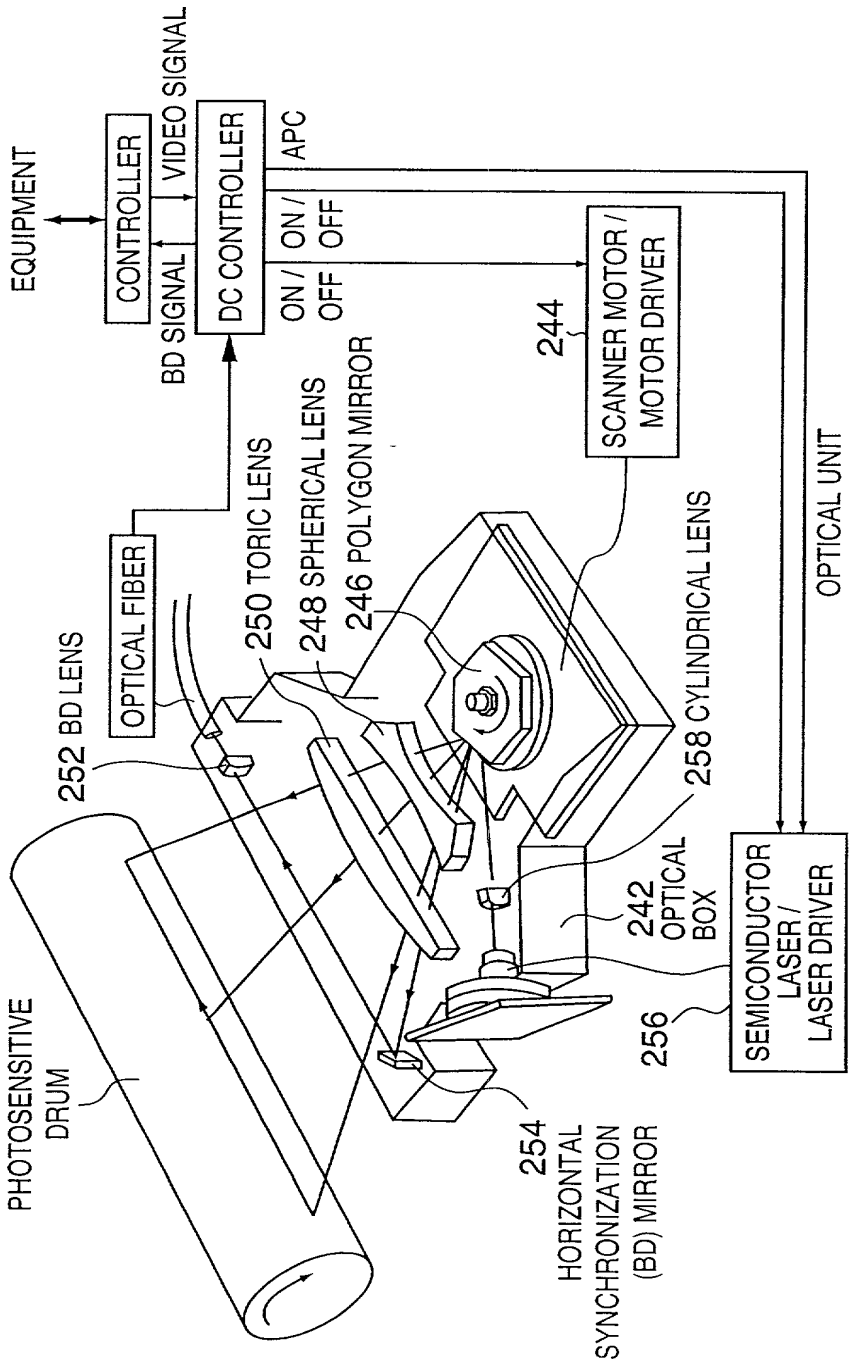

FIG. 30

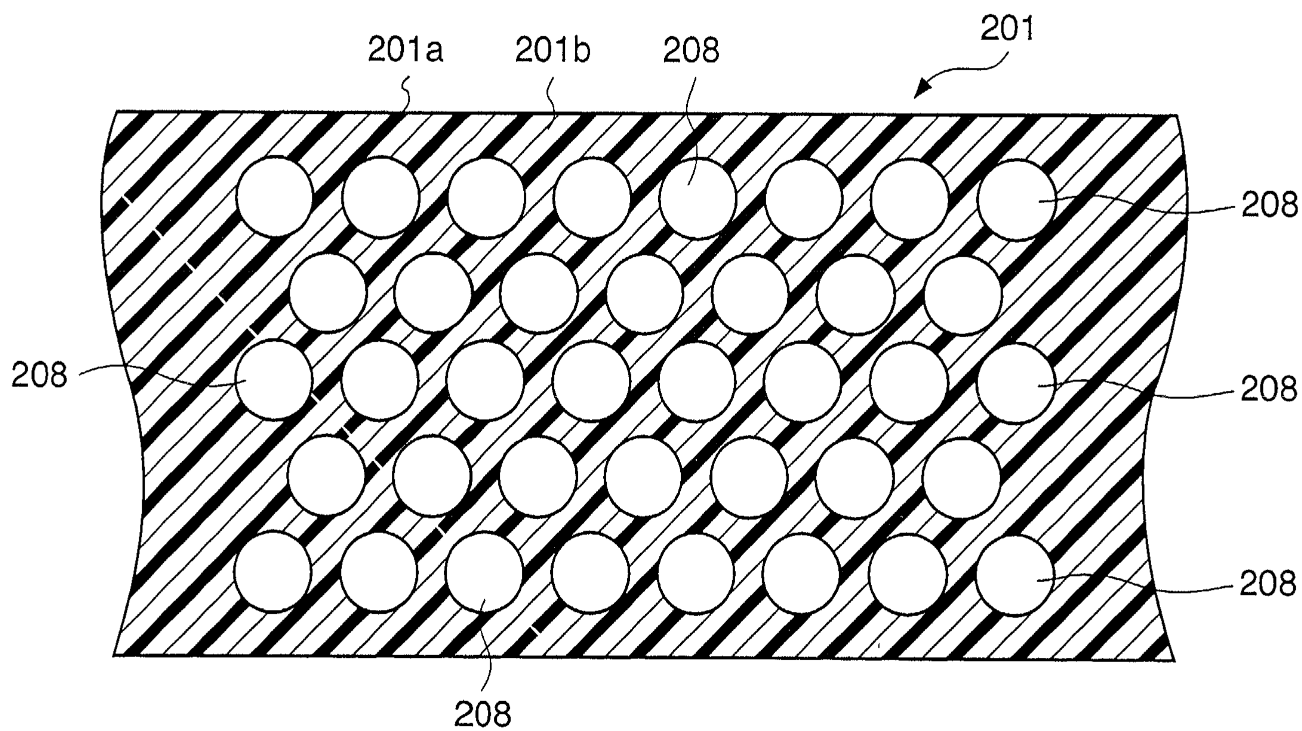

FIG. 31

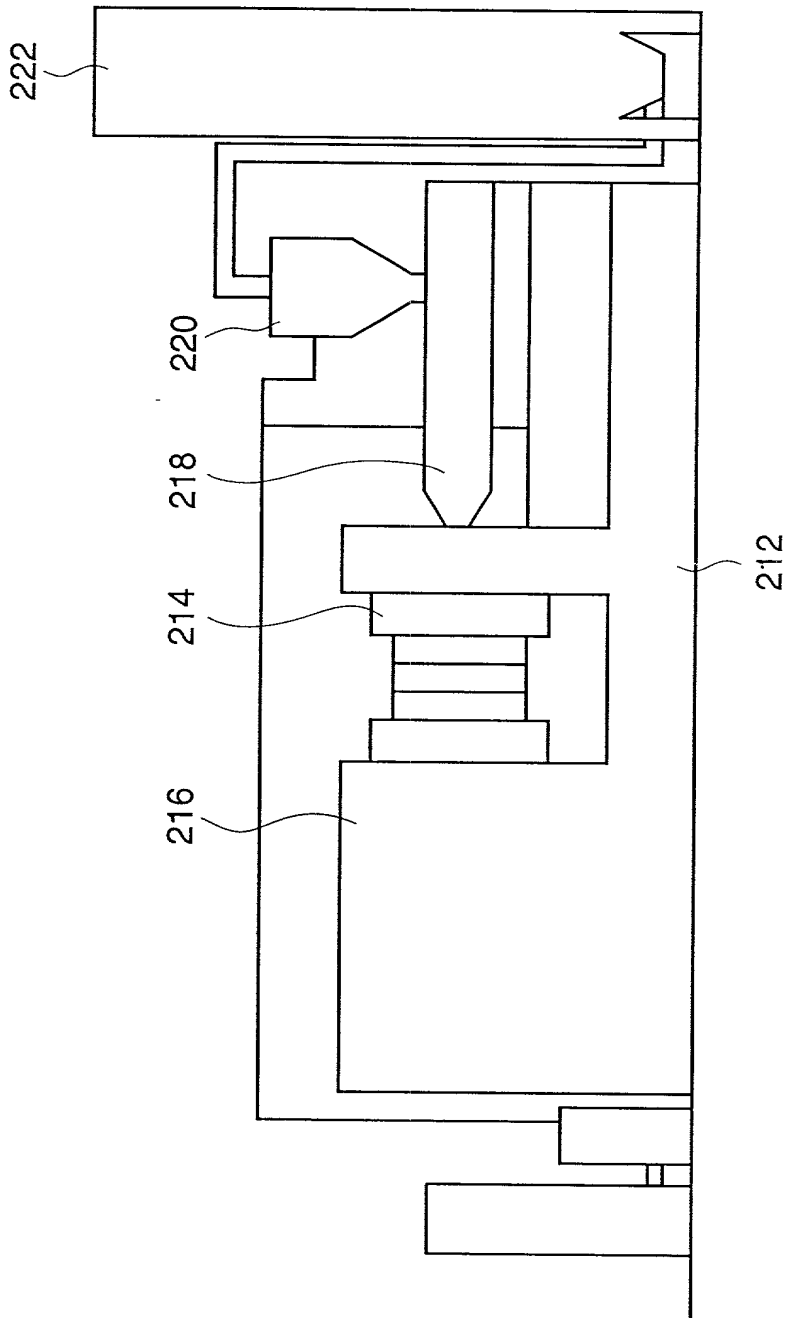

FIG. 32

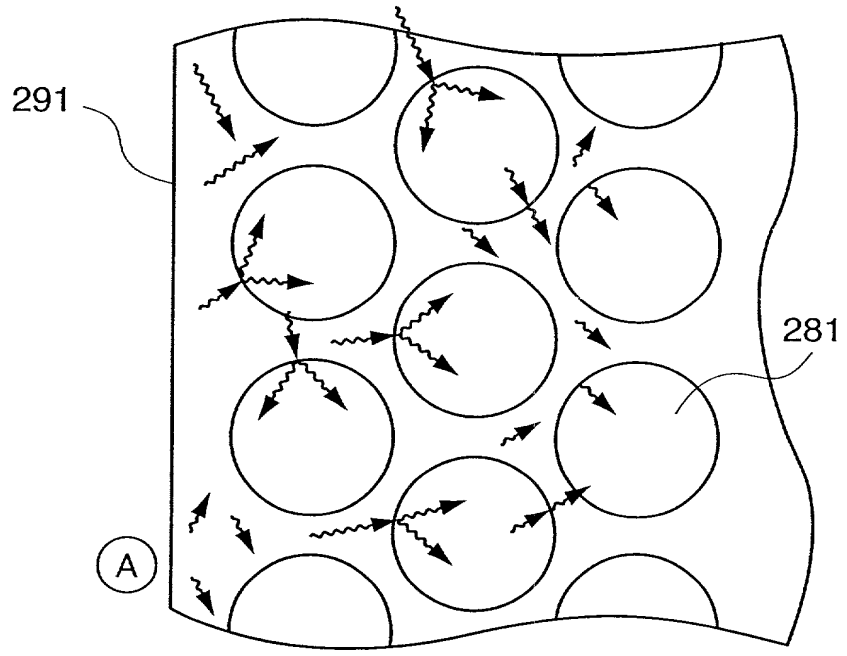

FIG. 33

RESIN MATERIAL	PPO1	PPO2	PC2	ABS	HIPS	PC/ ABS	PC/ ABS GF35	PPO GF25 MD10	PPO GF25 MD10	PPO3	PC GF25	PC GF35
CELL DIAMETER	10	20	15	20	15	15	25	25	25	45	18	35
GAS TYPE	CO_2	CO_2	CO_2	CO_2	CO_2	CO_2	CO_2	CO_2	N_2	N_2	N_2	N_2
THICKNESS	2.5	2.5	2.5	2.0	1.5	2.0	2.5	2.5	2.5	2.5	2.5	2.5
WEIGHT REDUCTION	20	25	25	20	15	22	24	28	18	12	9	14

CELL DIAMETER μm, THICKNESS mm, WEIGHT REDUCTION %
GF : GLASS FIBER
MD : MINERAL

F I G. 34

MATERIAL TYPE	CELL DIAMETER μm	THICKNESS	DAMPING FACTOR dB/sec	ELEXURAL RIGIDITY 1	ELEXURAL RIGIDITY 2
PPO	20	2.5	58	—	0.85
PC	15	2.5	75	—	0.95
ABS	20	2.0	88	—	0.7
HIPS	15	1.5	92	—	0.7
PC/ABS	15	2.0	82	—	0.75
PC/ABS GF35%	25	2.5	105	0.95	—
PPO GF25% MD10%	25	2.5	98	0.9	—
CONVENTIONAL PRODUCT	—	2.5	35	1.0	1.0
ALUMINUM ALLOY	—	1.0	10.5	—	—